IX. FISHES

By N. B. MARSHALL, M.A.

THE collection comprises 113 species, of which 1 is new, while 4 sub-species have been proposed. There are 11 new records for the Red Sea (these being indicated by an asterisk preceding the name of the species).

Collections were made from 28 December 1949 to 16 February 1950, coming from various localities along the Sinai shores of the gulf and from an area around the entrance. These include Aqaba, Faraun Island, Graa, Mualla, Wasit, Hobeik, Dahab, Um Nageila, and Abu Zabad within the gulf and Tiran Island, Sanafir Island, Sherm-el-Moiya, Sherm Sheikh, and Ras Muhammad Bay around the entrance. For the positions of these localities reference should be made to the chart in the introduction to this series of reports.

The fishes were captured by a variety of methods: cast-net, fish-trap, hand-lines, trolling gear, and dip-net. In addition many were taken by bringing up pieces of coral and breaking them open to obtain the enclosed fishes, while a number were obtained from pools along the reef at low water. The method of capture is indicated under each species, giving certain information on the habits of the fish. For example, those taken by cast-net occurred singly or in shoals in shallow water close to the shore, while those taken by trolling spoon or live bait were nearly always caught along the seaward edge of reefs, where they appear to station themselves to prey on smaller fishes living in association with coral. Clearly those found within pieces of coral must live in close association with it, darting back to shelter on being disturbed by the diver. Perhaps no more striking way of appreciating the direct or indirect dependence of so many tropical fishes on coral can be obtained than through the many ways necessary to obtain them as specimens.

SELACHII

CARCHARINIDAE

Negaprion acutidens (Rüppell)

1 specimen of length 660 mm.[1] taken close inshore in Ras Muhammad Bay.

Carcharinus melanopterus (Quoy & Gaimard)

1 specimen of 535 mm. caught by hand-line at Sanafir Island.

Carcharinus albimarginatus (Rüppell)

1 specimen of 870 mm. caught by hand-line at Sherm Sheikh.

[1] Except for the Selachii and the eels, lengths throughout this paper refer to the standard length.

RHINOBATIDAE

Rhinobatus halavi (Forskål)

Six specimens were taken in very shallow water in Ras Muhammad Bay. One of these is a female of length 507 mm., while the rest are males ranging from 355 to 520 mm.

DASYATIDAE

Dasyatis uarnak (Forskål)

One specimen taken by hand-line at a depth of 10 fathoms at the anchorage in Sanafir Island. The disk is about 1,000 mm. in length and 1,250 mm. wide. The tail, from which the whip-like end is missing, has a length of about 1,250 mm.

Taeniura lymma (Forskål)

Three specimens were obtained by cast-net close inshore at Sanafir Island (length 570 mm.), and at Mualla (length 445 mm.) and Um Nageila (length 564 mm.) within the Gulf of Aqaba.

ISOSPONDYLI

CLUPEIDAE

Sub-family DUSSUMIERIINAE

Spratelloides delicatulus (Bennett)

Individuals of this species were taken with a dip-net and Aldis lamp at night. Faraun Island: 10 specimens from 21 to 50 mm. Sanafir Island: 15 specimens from 40 to 45 mm.

Spratelloides gracilis (Schlegel)

Like the preceding species, this was caught by dip-net at night in the light of an Aldis lamp. Hundreds of specimens were taken at the anchorage at Sanafir Island, ranging in length from 9 to 39 mm.

I have compared some of these specimens with material in the museum collections from Japan and Formosa (the type locality being along the south-east coast of Nagasaki). There are differences in the number of pectoral and anal fins as shown in the table below:

	Pectoral (left)			*Anal*			
No. of rays . .	13	14	15	11	12	13	14
Red Sea specimens .	3	7		5	7	1	
Japanese specimens .		3	6		2	6	2

On the basis of the above counts it seems not unlikely that the Red Sea populations should be separated as a distinct sub-species; but lacking data from areas between the end points of the range of this species it is considered premature to subdivide it.

INIOMI

SYNODONTIDAE

Synodus variegatus (Lacépède)

One specimen of 130 mm. taken in a pool at Dahab.

APODES

MURAENIDAE

Echidna nebulosa (Ahl)

Two specimens of 444 and 460 mm. taken on the reef at Abu Zabad at low tide.

Echidna polyzona (Richardson)

One specimen from Abu Zabad of 195 mm. and two from Sanafir Island of 115 and 165 mm. The latter were found in a piece of madreporarian coral.

Gymnothorax meleagris (Shaw)

Seven specimens were obtained from the following localities: Dahab (108 mm.), Abu Zabad (145 and 160 mm.), Sanafir Island (111, 165, and 180 mm.), Sherm Sheikh (100 mm.). Except those from Abu Zabad, which were obtained on the reef at low tide, all were found in pieces of madreporarian coral brought up for examination.

Gymnothorax flavimarginata (Rüppell)

One specimen of 295 mm. taken on the reef at Abu Zabad at low tide and one of 880 mm. from Ras Muhammad Bay.

Gymnothorax geometrica (Rüppell)

Two examples of 130 and 143 mm. taken from pieces of coral at Sherm-el-Moiya and Sanafir Island respectively.

The body colour of these specimens was fawn with the pattern of dark pigment

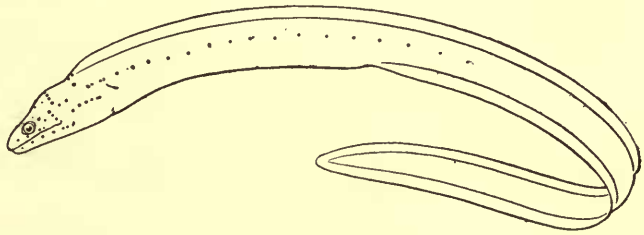

FIG. 1. An immature specimen of *Gymnothorax geometrica* (Rüppell) from Sherm-el-Moiya in the northern Red Sea, showing the pattern of dark spots on the head and body.

spots on the head looking rather like a series of lateral line pores (see Fig. 1). These spots extend down the mid flanks as a single line, extending just beyond the anus.

This spot pattern was also found in specimens from the collections labelled *Gymnothorax thyrsoidea* (Richardson): 2 from Rodriguez, 1 from the Seychelles, 1 from Muscat. These specimens differed from those listed above in having a dotted and speckled body coloration, but as all these Indian Ocean examples were much larger it is likely to be a difference due to age. Rüppell's (1828) figure shows a mottled body coloration.

There can be no doubt that *G. geometrica* (Rüppell) and *G. thyrsoidea* (Richardson) are very closely related, the only apparent difference between them being the absence of the spot pattern in the latter. However, as this pattern seems quite constant in *G. geometrica* and as the pattern only appears to be found in individuals from the western Indian Ocean, the two species have been kept separate. Further work may perhaps show that what is now called *geometrica* is a western Indian race of a widely spread species. (This species will, of course, need to be called *G. geometrica*—this name having priority over *G. thyrsoidea*.)

If *Gymnothorax geometrica* is a distinct species its distribution must include the western Indian Ocean as well as the Red Sea.

Uropterygius polyspilus (Regan)

One specimen from Sanafir Island of length 201 mm. taken in a piece of coral.

Schultz (1943) has suggested that this species is perhaps the young of *Uropterygius tigrinus* (Lesson). Examination of the above specimen, together with the type specimen from Tahiti (length 183 mm.) and two specimens from Samoa (331 mm.) and Zanzibar (715 mm.), shows that *polyspilus* is distinct from *tigrinus* (a specimen of 860 mm. was examined) in the following characters:

1. The number and size of the outer maxillary teeth: 20–28 in *polyspilus*, which are much smaller than the inner series of maxillary teeth; 12–13 in *tigrinus*, which are nearly the size of the inner series. (Bleeker, *Atlas Ichthyologique*, **4**, 1864: 113, counts 16 outer maxillary teeth for *tigrinus*. The figure on plate 165 shows them almost equal in size to the inner series.)
2. The proportions between trunk and tail: about equal in length in *polyspilus*, but in *tigrinus* the trunk is about 1·7–1·8 times longer than the tail.
3. The proportions between the eye and the snout: in *polyspilus* the length of the snout is from 1·7 to 1·8 times the diameter of the eye, whereas in *tigrinus* the snout is about 2–3 times the eye diameter.

SYNENTOGNATHI

BELONIDAE

Strongylura crocodilus (Lesueur)

One specimen from Sanafir Island of 465 mm.

HEMIRHAMPHIDAE

Hemirhamphus far (Forskål)

One specimen from Sanafir Island of 300 mm.

EXOCOETIDAE

Danichthys rondeletii (Cuvier & Valenciennes)

Four specimens taken off Alexandria, which were attracted on board by a light. Lengths 152, 164, 173, and 180 mm. Bruun (1935) has suggested that *D. rondeletii* in the Mediterranean might prove to be a dwarf race distinct from the Atlantic form. Examination of the above specimens, 2 others from the Mediterranean (B.M. Reg. No. 73.4.21.2–3) and 1 from the Atlantic (B.M. Reg. No. 71.12.28.8) has yielded data which when added to those listed by Bruun and Breder (1938) provides evidence to support this suggestion.

The essential differences between the two forms are in the number of pectoral rays and transverse scales (and very probably in the sizes attained, the Atlantic form being known up to 234 mm. in standard length and the Mediterranean up to 187·5 mm.). These differences are shown below:

Atlantic specimens	*Pectoral rays*	*Mediterranean specimens*
1	16	3
11	17	9
5	18	1
1	19	

Atlantic specimens	*Transverse scales (between origin of dorsal fin and lateral line)*	*Mediterranean specimens*
2	6½	9
13	7½	1

It would appear from these data that the Mediterranean form can nearly always be separated from the Atlantic by the number of transverse scales. If more evidence, in particular more from the Mediterranean, shows this is so, then this species must be split into Atlantic and Mediterranean sub-species.

MICROCYPRINI

CYPRINODONTIDAE

Aphanius dispar (Rüppell)

One female of 32 mm. taken on the reef at Abu Zabad at low tide.

SOLENICHTHYES

FISTULARIIDAE

Fistularia villosa Klunzinger

Four specimens from Dahab from 600 to 790 mm. Another specimen of 105 mm. taken with a dip-net at Sanafir Island is probably of this species. In determining this species I have used the revision by Duncker & Mohr (1925) and other specimens in the collections.

The colour was noted as follows: 'a line of misty-blue spots on either side of the mid-dorsal line extending from the pectoral fins to the dorsal. Below this line (about ½") a continuous misty-blue line extended from about 1" in front of the pelvics to 1" behind the end of the dorsal, thereafter continuing as a line of spots.'

SYNGNATHIDAE

Micrognathus brevirostris (Rüppell)

Three specimens found in a piece of coral at Sanafir Island. Two males of 37·0 and 47·5 mm. and one female of 44·0 mm.

BERYCOMORPHI

HOLOCENTRIDAE

Holocentrum spiniferum (Forskål)

Three specimens taken by hand-line at Sanafir Island (278 and 300 mm.) and Sherm Sheikh (295 mm.) at depths of about 10 fathoms.

Holocentrum sammara (Forskål)

One specimen from Sanafir Island (length 134 mm.).

Holocentrum diadema Lacépède

Two specimens of about 45 mm. from a piece of coral at Tiran Island.

Holocentrum lacteoguttatum (Cuvier & Valenciennes)

Two specimens of 45 and 54 mm. Taken at low tide on the reef at Abu Zabad.

PERCOMORPHI

(Sub-order PERCOIDEA)

SERRANIDAE

(Sub-family SERRANINAE)

Plectropoma maculatum (Bloch)

One specimen of 440 mm. caught by hand-line at Sanafir Island.

Variola louti (Forskål)

Two specimens of 385 and 287 mm. taken by hand-line at Dahab (10 fms.). This species could also be caught by trolling a spoon or live bait.

Cephalopholis miniatus (Forskål)

Two specimens of 280 and 287 mm. taken by hand-line at Dahab.

Cephalopholis hemistictus (Rüppell)

Three specimens, two from Dahab of 131 and 140 mm. and one from Hobeik of 131 mm.

Intensive field and laboratory work may show the two above species to be synonymous. Klunzinger (1884) states that the only distinguishing feature is in the coloration, which he says is constant in *hemistictus*. There is, however, considerable variability. The usual body colour in *hemistictus* is brownish or dark olive-green with small bright blue, ocellated spots on the head and lower half of the flanks (mainly found on the thoracic and abdominal regions), while there is a broad yellow edging to the pectoral fin. The three specimens from the Gulf of Aqaba differ from this in the general body colour, this being a bright red as in *C. miniatus*. (Two other specimens from the Gulf of Aden and one from the Makran coast also must have had this coloration.) What is also interesting on all these specimens are the pale pelvic fins with a narrow outer black edging which is also found in *C. miniatus* (in typical *C. hemistictus* they have a general, dusky pigmentation). Again, the area of the body covered with the blue spots in *hemistictus* varies considerably from being confined to part of the abdominal region to practically extending over the lower half of the flanks, with a few spots appearing dorsally above the lateral line. Finally in five specimens labelled *Epinephelus miniatus* from Mombasa there are two specimens of 226 and 242 mm. with the normal colour pattern, while the remaining three from 151 to 171 mm. (which agree in all characters but colour with the above two) are completely plain coloured. There is no trace of spots and only a faint dark edging to the caudal and anal fins can be seen. Presumably these were coloured a bright red in life.

Although it is quite possible that these species merge with one another, they have been separated particularly on account of the difference in distribution, *Cephalopholis hemistictus* being confined to the Red Sea and western Indian Ocean, whereas *C. miniatus* occurs throughout the Indo-West-Pacific area. There is here an interesting parallel with the eels *Gymnothorax geometrica* and *G. thyrsoidea* which were discussed earlier in this report.

Epinephelus summana (Forskål)

One specimen of 440 mm. from Sanafir Island taken by hand-line.

Epinephelus fuscoguttatus (Forskål)

Six specimens. Four from Sanafir Island from 325 to 890 mm. caught by hand-line in depths from 5 to 20 fathoms. Two from Abu Zabad of 51 and 123 mm. taken on the reef at low tide.

Epinephelus fasciatus (Forskål)

Seventeen specimens taken at the following localities: Dahab, 5 from 34 to 175 mm.;

Hobeik, 3 from 190 to 220 mm.; Abu Zabad, 7 from 46 to 76 mm. collected from pools on the reef at low tide; Sanafir Island, 1 of 43 mm.; Sherm Sheikh, 1 of 205 mm.

(Sub-family THERAPONINAE)

Therapon jarbua (Forskål)

Thirteen specimens captured by cast-net at Sherm Sheikh (12 from 79 to 116 mm.) and at Abu Zabad (1 of 167 mm.).

Investigations of these specimens together with others in the collections has shown that there are certain regional differences in the number of dorsal spines and the relation between the depth of body and the standard length as shown in the following table:

Area	*No. of dorsal spines* 11	12	$\frac{depth}{length} \times 100$	*No. of specimens*	*Size range (mm.)*
Red Sea	13	—	29·5–32·0	13	79–167
Arabian coast	5	—	32·0–35·0	5	80–276
Persian Gulf	4	2	33·0–38·0	6	58–63·5
Coasts of India and Ceylon	12	—	32·1–38·6	12	26–113
East African area	2	6	30·7–35·0	8	54–204
East Indies	1	10	32·2–37·0	11	23–151
Philippine Islands	1	2	36·1–37·2	3	90–117
Fiji and Samoa	—	2	35·5–35·7	2	141–154
China	—	3	31·5–32·9	3	34·5–96·5
Australia	—	2	30·9–33·6	2	67–210

Although these data are rather limited, it is clear that in the Red Sea *Therapon jarbua* has 11 spines in the dorsal fin (previously found by Klunzinger, 1884) and also tends to be slenderer in form than representatives from the Indo-Pacific areas. Furthermore, the proportion of the Indian Ocean specimens having 11 as against 12 spines is 23:8, whereas in the Pacific Ocean this is 2:19. Of specimens from the Pacific, those from the Philippines, Fiji, and Samoa have the deepest body form.

It is thus quite evident that the populations of *Therapon jarbua* are by no means uniform in character. Whether, for example, the Red Sea population can be considered to be part of a sub-species found mainly in the north-west Indian Ocean (having 11 dorsal spines), which intergrades over a wide area with a typical Pacific sub-species (having 12 dorsal spines), can hardly be decided on the present data. It is, however, a problem worth much further investigation.

During this work it became necessary to decide whether *Therapon servus* (Bloch) is distinct from *T. jarbua* (Forskål). Weber & de Beaufort (1931) have synonymized them but refer to the work of Jordan & Thompson (1912), who decided that they were good species, particularly separated by the longitudinal scale counts just above the lateral line. The present work confirms Jordan & Thompson's conclusions and shows that in general *Therapon servus* has relatively smaller scales than *T. jarbua*, as shown in the following table.

Scale count	*Therapon jarbua*	*No. specimens seen*	*Therapon servus*	*No. specimens seen*
1. Longitudinal series above the lateral line . .	77–89	57	92–105	12
2. Transverse scales . .	(12) 14–17 / 25–30	55	17–21 / 30–35	12
3. Rows of scales on preoperculum . . .	8–11	57	11–13	12

SERRANIDAE

Sub-family GRAMMISTINAE

Grammistes sexlineatus (Thunberg)

Three specimens from 70 to 82 mm. taken at low tide on the reef at Abu Zabad.

Sub-family PSEUDOCHROMIDINAE

Pseudochromis olivaceus Rüppell

All the examples of this species were taken from pieces of coral brought up by a diver. Within the Gulf of Aqaba collections were made at Graa (2 specimens of 26 and 45 mm.), Mualla (4 specimens of 23–47 mm.), and at Dahab (4 specimens from 37 to 59 mm.). There are also 34 from 26 to 70 mm. taken at Sanafir Island and 8 from 29 to 54 mm. taken at Sherm-el-Moiya.

Comparison has been made between the Gulf of Aqaba individuals and some of those taken outside the entrance in the Red Sea. There does appear to be some difference in the number of pectoral rays, which are tabulated below:

Pectoral rays	*17*	*18*	*19*
Gulf of Aqaba . .	3	6	1
Sanafir Island . .	—	10	2

This species is confined to the Red Sea.

PLESIOPIDAE

Plesiops nigricans (Rüppell)

Twenty-three specimens from 33 to 63·5 mm. collected at Abu Zabad at low tide.

CHEILODIPTERIDAE

Apogon endekataenia Bleeker

Nine specimens from Abu Zabad from 53 to 61 mm., collected on the reef at low tide.

These specimens agree in structure with two specimens in the collections (labelled as types) which were obtained from Bleeker (B.M. Reg. No. 1880.4.21.59–60). The latter have nearly lost all trace of colour but still retain the remains of the spot on

the base of the caudal fin which Weber & de Beaufort (1929) list as one of the characters separating *A. endekataenia* from *A. novemfasciatus* C.V. Comparison of these specimens with those of *novemfasciatus* shows the two to be very distinct in tooth character. In the latter the teeth are relatively large, there being 4 rows in the upper and lower jaws while in *endekataenia* there are from 6 to 9 somewhat irregular rows of smaller teeth. Comparison of specimens of equal size shows that the teeth of *novemfasciatus* are about twice the size of those of *endekataenia*.

Examination of the museum collections has not revealed any examples of *A. novemfasciatus* from the Red Sea or Indian Ocean. Klunzinger (1884) notes that his specimens (which he names *A. fasciatus* White) show clearly the black spot on the base of the tail. Smith (1949), however, records it as quite common north of Zululand.

Cheilodipterus quinquelineatus Cuvier & Valenciennes

Three specimens from 31 to 38 mm. taken at Abu Zabad.

LATILIDAE

****Malacanthus hoedtii*** Bleeker

One specimen from Sherm Sheikh of 207 mm.

CARANGIDAE

Caranx fulvoguttatus (Forskål)

One specimen from Sanafir Island of 170 mm.

Caranx sexfasciatus Quoy & Gaimard

Two specimens of 544 and 800 mm. caught by trolling a spinner at Sanafir Island.

LUTIANIDAE

Lutianus bohar (Forskål)

Two specimens caught by hand-line at Sanafir Island (length 310 mm.; depth 20 fms.) and at Sherm Sheikh (length 357 mm.; depth 6 fms.).

Lutianus argentimaculatus (Forskål)

One specimen of 345 mm. caught by hand-line at a depth of 20 fms. at Sanafir Island.

Lutianus fulviflamma (Forskål)

Three specimens caught by hand-line (two from Sanafir Island of 222 and 232 mm. taken at 20 and 8 fms. respectively; one from Sherm Sheikh of 209 mm. from 6 fms.)

Lutianus kasmira (Forskål)

Six specimens taken on hand-lines Four from Sherm Sheikh at 147–182 mm. and two from Hobeik at 209 and 211 mm.

Aphareus rutilans Cuvier & Valenciennes

One specimen of 765 mm. obtained from the cold store at Aqaba.

This is one of the finest food fishes taken in the Gulf of Aqaba and is known to the Arab fishermen as Faris. It is caught by hand-line mainly at depths of about 100 metres.

MULLIDAE

Parupeneus macronema (Lacépède)

Five specimens. Three obtained by cast-net (two at Dahab of 145 and 149 mm. and one at Sanafir Island of 96 mm.). The other two of 83 and 84 mm. were caught in a fish-trap at Aqaba at a depth of 10 fathoms.

LETHRINIDAE

Lethrinus nebulosus (Forskål)

Two specimens of 320 and 450 mm. caught by hand-line at Sanafir Island (5 fms.) and Dahab (15 fms.) respectively.

Lethrinus mahsena (Forskål)

Four specimens taken at Dahab (two of 290 and 310 mm. at 12 fms.) and Sanafir Island (two of 225 and 257 mm. at 5 fms.).

Lethrinus microdon Cuvier & Valenciennes

Five specimens, of which three are from Aqaba (86–97 mm.) taken in a fish-trap at a depth of 10 fathoms. The other two were caught by hand-line at Dahab (length 317 mm.; depth of water 7 fms.) and Sanafir Island (length 360 mm.; depth 5 fms.).

Lethrinus mahsenoides ([Ehrenberg] Cuvier & Valenciennes)

Twelve specimens. Seven from Aqaba taken in a fish-trap set at 10 fathoms. Three from Dahab of 176, 183, and 184 mm. caught by hand-line at a depth of 10 fathoms. One from Hobeik of 200 mm. from a depth of 10 fathoms, and one from Sherm Sheikh of 162 mm. from 6 fathoms.

Weber & de Beaufort (1936) have remarked that *L. mahsenoides* from the Red Sea is hardly separable from *L. ornatus* C.V. (= *L. insulindicus* Bleeker). I have compared the above specimens and one of Klunzinger's from the Red Sea (labelled *mahsenoides*) with those labelled '*mahsenoides*' and *insulindicus* taken outside the Red Sea. I could find no significant differences.

Gymnocranius griseus (Schlegel)

One specimen from Hobeik of 300 mm. taken by hand-line at a depth of 10 fathoms.

The above specimen has been compared with two from Mauritius (B.M. Reg. Nos. 1932.8.8.22 and 1934.2.22.25) and one from the Loyalty Islands (77.7.24.2), but there appear to be no differences. Specimens from nearer the type locality (SW. coasts of

Japan) differ from the Red Sea and Indian Ocean examples in being deeper bodied (these were from Hong Kong, B.M. Reg. No. 1939.1.17.38 and the Inland Sea of Japan, B.M. Reg. No. 1907.12.23.230–1). The depth in these is about half the standard length as against $\frac{5}{11}$ to $\frac{5}{13}$ in the Red Sea and Mauritius specimens. There is, also, a difference in coloration, for the Red Sea and Indian Ocean specimens have the wavy blue lines across the head, a coloration which never seems to be present in Pacific Ocean fishes of this species. Fowler (1933) has even made this difference the basis for two sub-genera.

Sparidae

Sparus bifasciatus (Forskål)

Two specimens from Sanafir Island (92·5 mm.) and from Um Nageila (154·0 mm.).

On comparing these specimens with others in the museum collections it became quite evident that there are two definite colour varieties. The first, which is found in the Red Sea, the Gulf of Aden, along the South Arabian coast (Muscat), and in the Persian Gulf, has plain hyaline or yellow dorsal and caudal fins. The other from the Makran coast of Baluchistan, the north-western Indian coast, and the East African area (specimens from Kosi Bay, Zululand, and Rodriguez) always has a black edging to the dorsal fin and sometimes a black edging in the fork of the caudal. Reference to the literature on this species confirms this difference in pigmentation and the geographical range of each type.

In body proportions and height and lengths of the fins there are no significant differences between these two forms. In fin ray and scale counts there are also no differences, except that there appears to be a definite tendency for the East African examples to have 13 rays in the soft dorsal rather than 12. Smith (1938) also gives 13 as the number of dorsal rays in a specimen from Natal. Counting the latter, five out of six East African examples have 13 rays, whereas from the rest of the area of distribution only one out of eighteen had this number; the rest had 12.

It is not the intention to do more at this stage than draw attention to this differentiation within the populations of this bream. More data on the Baluchistan and north-west India populations would be of interest, for at present it appears that, although they have the same colour pattern as the East African, they tend to have 12 dorsal rays rather than 13 (5 out of 6 examined). Yet one specimen from this area did have 13 rays. It is of interest to note that in all instances this number was associated with a black-edged dorsal fin.

Sparus haffara Forskål

Two specimens of 165 and 172 mm. taken by cast-net at Sanafir Island.

Argyrops spinifer (Forskål)

One specimen of 357 mm. caught by hand-line at Dahab at a depth of 10 fathoms.

Diplodus noct ([Ehrenberg] Cuvier & Valenciennes)

Ten specimens taken by cast-net at the following localities: Dahab (2 of 66·0 and 136 mm.), Abu Zabad (2 of 140 and 146 mm.), Sanafir Island (6 from 76·0 to 88·0 mm.).

The distribution of this species is given as the Red Sea, the Arabian and Indian coasts, and Madagascar (Fowler, 1933).

Close comparison of the above material with specimens labelled *Diplodus noct* from Karachi (1) and from the Persian Gulf (11) (from Bushire) has shown them to be quite different. The latter are actually *Diplodus sargus* (Linnaeus). They are, in fact, the same fish as another series labelled *Diplodus capensis* from Muscat, Arabia, the latter being a synonym of *D. sargus*.

The characters showing the differences between *Diplodus noct* from the Red Sea and *D. sargus* from the Persian Gulf and north-west Indian coast are listed below. The measurements and counts on *D. noct* were made on the 10 specimens listed above and 1 other of length 212 mm. from Klunzinger's collection, while those on *D. sargus* were obtained from the 11 specimens from the Persian Gulf (ranging in length from 62·0 to 130·0 mm.), 1 from Karachi (of 109 mm.), and 4 from Muscat (from 140 to 213 mm.).

Diplodus noct (Ehrenberg) (C.V.). The greatest depth of the body is from 39·0 to 42·1 per cent. of the standard length. Dorsal XII. 12–14 (5 specimens with 13 rays, 4 with 14, 1 with 12). Anal III. 12–13 (5 with 12 rays, 6 with 13). Scale count above and below lateral line 6–7/15–16. Number of gill rakers on 1st arch 6–7+1+ 12–13.

Diplodus sargus (L.). The greatest depth of the body is from 45 to 50 per cent. of the standard length. Dorsal XII. 13–15 (2 specimens with 13 rays, 10 with 14, and 2 with 15). Anal 12–14 (2 specimens with 12 rays, 9 with 13, and 4 with 14). Scale count above and below the lateral line 8–9/15–18. Number of gill rakers on 1st arch 6+1+9–10.

Reference to the literature suggests, in conjunction with the above data, that *D. noct* is confined to the Red Sea. Day (1875) records this species from the Red Sea and Sind (NW. India). His synopsis (p. 133) fits very well with the characters listed above for *D. noct* and his figure (pl. 32, fig. 5) is almost certainly drawn from a specimen of *noct*. Unfortunately he does not state the locality of this specimen, but does mention that this fish is common at Suez. His specimens from NW. India may well have been *D. sargus*.

Sargus kotschyi Steindachner from the Arabian Gulf, Madagascar, which is synonymized with *Diplodus noct* by Fowler (1933), is probably a synonym of *D. sargus*. In particular the number of scale rows (8) above the lateral line is a good indication.

In the course of this work specimens of *Diplodus sargus* from the Mediterranean were compared with those from Muscat and the Persian Gulf and good agreement found between them. The only difference found was in the number of scale rows above the lateral line, which in the Mediterranean examples was 7 to 8 compared to 8 to 9 in those from the Arabian area. It is hoped at a later date to investigate the degree of differentiation within this species.

Crenidens crenidens (Forskål)

Twelve specimens taken by cast-net at the following localities: Dahab (8 specimens from 68·5 to 95 mm.), Sanafir Island (4 specimens from 107 to 120 mm.).

Comparison of these specimens with others from Aden (6 collected by Mr. A. Fraser-Brunner) and Karachi (13) has shown that this species can be divided into two sub-species.

The first is typified by specimens from the Red Sea. The diagnosis which follows is based on the 12 specimens listed above, 1 of 123 mm. from the Red Sea (Rüppell's collection), Ismailia (Suez Canal) (1 of 152 mm.), Korbrat, Suez (1 of 109 mm.), and the Gulf of Suez (1 of 95 mm.). The latter three specimens were collected by the Cambridge Expedition to the Suez Canal, 1924.

Crenidens crenidens crenidens (Forskål)

Depth of body 33·3–38·9 per cent., depth of caudal peduncle 9·9–10·9 per cent., height of third dorsal ray 9·6–11·1 per cent., and length of pelvic fin 18·1–21·2 per cent. of the standard length. Rows of scales above lateral line (from origin of dorsal) 5–6 (7 specimens with 5 rows and 9 with 6 rows). Rows of scales below lateral line 11–12 (2 specimens with 11 rows and 14 with 12 rows). Red Sea.

Synonymy. Presumably all references to *Crenidens crenidens* (Forskål) or *Crenidens forskålii* C.V. from Red Sea localities must come under this sub-species.

Sparus crenidens Forskål, 1775, *Descript. Animal.*: 15 (type locality Red Sea: Djidda or Suez).
Crenidens crenidens, Norman, 1927, *Trans. zool. Soc. Lond.* **22:** 380.
Crenidens forskålii, Cuvier & Valenciennes, 1830, *Hist. Nat. Poiss.* **6:** 378, pl. 162 quater (type locality: Red Sea). Gunther, 1859, (partim) *Cat. Fish. Brit. Mus.* **1:** 424. Klunzinger, 1870, *Verh. zool. bot. Ges. Wien*, **20:** 748. Day, 1875, (partim) *Fishes of India*, **1:** 133.
Crenidens forskaelii, Day 1889 (partim) *Fauna British India* **2:** 35.

The second sub-species is typified by a series of 13 specimens from Karachi ranging in length from 52·5 to 164 mm. The following diagnosis is based on these individuals.

Crenidens crenidens indicus Day

Depth of body 43·3–49·1 per cent., depth of caudal peduncle 11·4–12·8 per cent., height of third dorsal ray 11·6–13·9 per cent., and length of pelvic fin 20·7–25·2 per cent. of standard length. Rows of scales above the lateral line 6–7 (3 specimens with 6 rows and 10 with 7 rows). Rows of scales below the lateral line 12–15 (3 specimens with 12 rows, 2 with 13 rows, 7 with 14 rows, and 1 with 15 rows). Karachi.

Synonymy.

Crenidens indicus, Day, 1873. The sea-fishes of India and Burma from Report on the sea fish and fisheries, p. clxxxvi, No. 184. Day, 1875, *Fishes of India*, pt. 1: 132, pl. 32, fig. 4. Day, 1889, *Fauna of British India*, **2:** 34, fig. 13. Steindachner, 1907, *Denkschr. Akad. Wiss. Wien.* **71** (1): 136. Blegvad, 1944, *Danish Sci. Inv. Iran*, **3:** 143, fig. 80, pl. viii, fig. 3.
Crenidens macracanthus, Gunther, 1874. *Ann. Mag. nat. Hist.* (4) **14:** 368 (type locality: Madras).

Of particular interest are the six specimens from Aden mentioned above which range from 127 to 167 mm. in length. These have the following proportions and

counts: Depth of body, 39·7–44·0 per cent., depth of caudal peduncle 11·1–12·0 per cent., height of third dorsal ray 9·0–11·0 per cent., and length of pelvic fin 20·3–21·5 per cent. of the standard length. Scale rows 6–12 (13 in one specimen).

It will be seen that these individuals resemble *Crenidens crenidens crenidens* in the relative height of the third dorsal ray and the scale counts, but in depth of body, caudal peduncle, and length of pelvic fin they are more like *C. c. indicus*. It was the examination of these intermediate specimens which partly suggested the differentiation of *C. crenidens* into Red Sea and Arabian Sea sub-species.

As the diagnosis shows, the latter sub-species *indicus* is quite distinct along the north-west coast of India and seemingly in the Iranian Gulf, to judge from pl. viii, fig. 3, in Blegvad's report (1944, loc. cit.). More specimens from the south Arabian coasts are clearly required.

There is also little comprehensive data from the East African area. Two specimens from Mombasa and Port Natal of 118 and 186 mm. respectively closely correspond with *C. c. indicus* in body proportions, but like *C. c. crenidens* have 6 and 12 rows of scales above and below the lateral line. On the other hand, the accurate figures of Smith (1938, fig. 21, and 1949, pl. 44, fig. 732), together with the descriptions, give much more the impression of *C. c. crenidens*. It is thus evident that many more specimens from this area must be studied before the *C. crenidens* complex can be more fully appreciated.

Pempheridae

Pempheris sp. (probably *P. moluca* C.V.)

Twenty-five juvenile specimens from 17 to 23 mm. caught by dip-net close inshore at Faraun Island.

Chaetodontidae

Chaetodon fasciatus Forskål

One specimen of 88 mm. caught by cast-net around coral at Sanafir Island.

This species is confined to the Red Sea.

Anisochaetodon auriga (Forskål)

Three specimens of 43, 48, and 51 mm. taken by cast-net at Sanafir Island.

None of these examples have the elongated fifth or sixth dorsal ray. The two smaller specimens have a round black spot towards the 'apex' of the dorsal fin.

Platax orbicularis (Forskål)

Nine specimens from 64 to 84 mm. taken by cast-net at Sanafir Island.

The above individuals together with two more from the Red Sea have been compared with examples from the Indian and Pacific Oceans (Ceylon (2), Seychelles (1), Mombasa (1), Singapore (1), Borneo (2), Philippines (2), Manado (3), and the coast of Savaii (1)).

There appear to be no differences except in the number of pectoral rays (counted in the left fin).

Pectoral rays	*16*	*17*	*18*	*19*
Red Sea . .	3	7	1	—
Indo-Pacific . .	1	4	7	1

POMACENTRIDAE

Amphiprion bicinctus Rüppell

One specimen of 52 mm. taken by dip-net among coral at Dahab.

Abudefduf biocellatus (Quoy & Gaimard)

Eighteen specimens from 34 to 62 mm. taken on the reef at Abu Zabad at low tide. Three of the above have the typical *biocellatus* colour pattern: the rest have only the posterior ocellus at the base of the last few dorsal spines.

Abudefduf sordidus (Forskål)

Three specimens of 87, 119, and 123 mm. caught by cast-net around rocks.

Chromis coeruleus (Cuvier & Valenciennes)

Forty-eight specimens, all taken from pieces of coral obtained by a diver at the following localities: Sanafir Island, 36 from 22 to 44 mm.; Sherm Sheikh, 9 from 27 to 34 mm.; Dahab, 3 from 18 to 36 mm.

Dascyllus aruanus (Linnaeus)

Forty-four specimens obtained from pieces of coral at the following localities: Sanafir Island, 38 from 17 to 50 mm.; Graa, 3 from 28 to 32 mm.; Dahab, 3 from 40 to 46 mm.

Dascyllus marginatus (Rüppell)

Five specimens from 20·5 to 36·0 mm. obtained from a piece of coral at Dahab (depth 25 fms.).

Comparison of these specimens and others from the Red Sea with those from localities in the Indian and Pacific Oceans has shown that a separate sub-species may occur in the Red Sea. A description of the diagnostic features follows below, based on the five specimens listed above, 1 from the northern Red Sea, taken off the Gulf of Aqaba (length 38·0 mm.), B.M. Reg. No. 1938.1.24.3; 2 from the Red Sea (of 39 and 42 mm.), B.M. Reg. No. 1935.9.1.5; 3 from the Kamaran Islands (from 32 to 41 mm.), B.M. Reg. No. 1937.4.26.8.10; and 18 from Massaua (from 24 to 44 mm.), B.M. Reg. No. 71.4.13.40.

Dascyllus marginatus marginatus (Rüppell)

(Fig. 2*a*)

Length of longest dorsal ray (usually the fifth) from 21·9 to 28·7 per cent. of the standard length (mean 23·8 per cent.; length of longest anal ray (usually the fourth) from 22·5 to 28·0 per cent. of the standard length (mean 25·3 per cent.). Rays in left pectoral fin (17) 18–19 (20) (2 specimens with 17 rays, 5 with 18 rays, 21 with

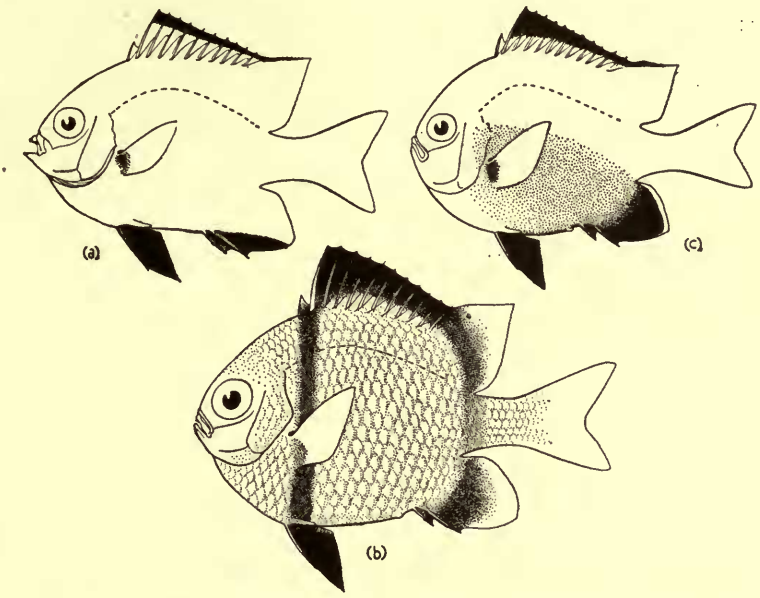

Fig. 2*a*. *Dascyllus marginatus marginatus*. Locality: Dahab, Gulf of Aqaba.

Fig. 2*b*. *Dascyllus marginatus reticulatus*. Locality: Philippine Islands.

Fig. 2*c*. A specimen of *D. marginatus* from Aden—intermediate in certain respects between the two above sub-species.

19 rays, and 1 with 20 rays). General body colour pallid to brownish (in spirits) with the anterior half to two-thirds of the trunk usually tending to be darker in colour than the rest of the body. Upper third to a half of spinous dorsal black; this edging continuing along the soft dorsal as a rather thinner band as far as the tips of the longest dorsal rays. Anal fin with membranes between the spinous and first 5 or 6 soft rays coloured black, contrasting sharply with the posterior half of the fin where the fin membranes are translucent.

Distribution. Red Sea.

Synonymy.

Pomacentrus marginatus Rüppell, 1828. *Atlas Reise nordl. Afrika. Fische des Rothen Meers.*: 38. pl. 8, fig. 2 (type locality: Massaua, Red Sea).

Dascyllus marginatus Cuvier & Valenciennes, 1830. *Hist. Nat. Poiss.* **5:** 439, pl. 133. Günther,

1862, *Cat. Fish. Brit. Mus.* **4:** 14. Klunzinger, 1871, *Verh. zool. bot. Ges. Wien* **21:** 520. Kossman & Rauber, 1877. *Zool. Ergebn. K. Acad. Wiss. Berlin,* **1:** 23. Borsieri, 1904, *Ann. Mus. Civ. Genova* (3) **1** (41): 214. Bamber, 1915, *J. linn. Soc. Lond.* **31:** 481.

The other material studied was as follows:

Specimens from the Gulf of Aden collected by Mr. A. Fraser-Brunner, 3 specimens from Alayu, British Somaliland (from 30·5 to 34·0 mm.); 5 specimens from Berbera, British Somaliland (from 27·5 to 35·5 mm.); 1 specimen from Perim (of 35 mm.); 1 from Aden (of 33·5 mm.) and 1 from Burum near Mukalla, Indian Ocean; 2 from Zanzibar, B.M. Reg. No. 64.11.15.100 and 65.3.18.35 (of 48·0 and 52·5 mm.); Pacific Ocean[1]; 3 from Rotuma, B.M. Reg. No. 97.8.23.141–143 (from 26·0 to 63·5 mm.)[1]; 1 from Borneo, B.M. Reg. No. 58.4.21.363 (of 42 mm.)[1]; 1 from Ponape, B.M. Reg. No. 76.5.19.7 (of 31·0 mm.), and 8 from Duquamete, Or Negros, Philippine Islands, B.M. Reg. No. 1933.3.11.440–7 (from 25·0 to 58·0 mm.). The type specimen of *Dascyllus nigripinnis* Regan was also examined (B.M. Reg. No. 1908.3.23.98).

Dascyllus marginatus reticulatus (Richardson)

(Fig. 2*b*)

Length of longest dorsal ray from 19·8 to 23·2 per cent. of the standard length (mean 21·1 per cent.). Length of longest anal ray from 19·1 to 24·5 per cent. of the standard length (mean 21·3 per cent.). Rays in left pectoral fin (19) 20–21 (1 specimen with 19 rays, 7 with 20 rays, and 8 with 21 rays).

General body colour brown to dark brown (in spirits), the darker edging of the scales often showing up as a reticulated pattern over the body. Spinous dorsal fin dark brown, this pigmentation not extending to the longest rays of the soft dorsal. Anal fin uniformly dark brown, although sometimes the distal half of the fin may appear lighter.

Distribution. Indo-West Pacific area (excluding the Red Sea).

Synonymy. This is not complete, but lists all the names which have been proposed for the Indo-Pacific individuals of this sub-species.

Heliases reticulatus, Richardson, 1845 (1846), *Rep. Brit. Ass. Adv. Sci. Ichth. China & Japan*: 254 (type locality: China Seas).
Tetradrachmum reticulatum, Bleeker, (1872), *Ned. Tijdschr. Dierk.* **2:** 145.
Dascyllus xanthosoma, Bleeker, 1851, *Natuurk. Tijdschr. Ned.-Ind.* **2:** 247.
Dascyllus marginatus, Playfair & Günther, 1866, *Fishes of Zanzibar*, **277:** 81.
Pomacentrus unifasciatus, Kner, 1868, *S.B. Akad. Wiss. Wien*, **58** (1): 31, 348, pl. 8, fig. 24.
Dascyllus nigripinnis, Regan, 1907, *Trans. linn. Soc. Lond. Zool.* (2) **12:** 228, pl. 24, fig. 5. Type locality: Maldives.
Dascyllus trimaculatus (non Rüppell), Fowler, 1918, *Copeia*, **58:** 64.

Finally the specimens from the Gulf of Aden were found to have the following characteristics:

Length of longest dorsal ray 21·4–24·6 per cent. of standard length (mean 22·7 per cent.). Length of longest anal ray 20·6–25·9 per cent. of standard length (mean 22·3 per cent.). Rays in left pectoral 17–19 (1 with 17, 2 with 18, and 8 with 19 rays). Colour in spirits dark purple-brown to brown with the caudal peduncle and the region

[1] These are labelled *Dascyllus xanthosoma.*

over the dorsal half of the body and below the dorsal fin lighter in colour. Distal half to two-thirds of spinous dorsal black, this continuing as a thin edging to the soft dorsal as far as the tips of the largest rays. Anal, except for a lighter posterior edging, brownish black (see fig. 2*c*).

It will be seen that these specimens are in certain respects intermediate between the two sub-species described above. In colour they are much like *D. m. reticulatus*, although that of the dorsal fin is more like *D. m. marginatus*.

In number of pectoral rays they are clearly closest to *marginatus*, but are perhaps intermediate in the height of the longest dorsal and anal rays. The existence of intermediate forms in the Gulf of Aden suggests that this is an area where the two sub-species meet and interbreed. Much more material is required, however, from both the southern end of the Red Sea and the Gulf of Aden to establish the interrelations of the sub-species.

Labridae

Labroides dimidiatus (Cuvier & Valenciennes)

One specimen of 27 mm. caught by hand-net among coral at Mualla.

Thalassoma güntheri (Bleeker)

Four specimens caught by hand-line at the following localities: Sanafir Island, 2 of 105 and 107 mm.; Tiran Island, 1 of 102 mm.; and Sherm Sheikh, 1 of 154 mm.

Thalassoma lunare (Linnaeus)

Two specimens of 115 and 151 mm. caught by hand-line at Ras Muhammad Bay.

Stethojulis axillaris (Quoy & Gaimard)

Two specimens of 53 and 66 mm. taken at Abu Zabad at low tide on the reef.

Stethojulis albovittata (Bonnaterre)

One specimen of 79 mm. taken at Abu Zabad at low tide on the reef.

****Halichoeres margaritaceus*** (Cuvier & Valenciennes)

Three specimens of 37, 43, and 51 mm. taken at low tide on the reef at Abu Zabad.

Cheilinus mentalis Rüppell

Eight specimens from 55 to 87 mm. taken at Aqaba in a fish trap set at 10 fathoms. De Beaufort (1940) has correctly synonymized *Cheilinus orientalis* Günther with this species. There are no differences between the above specimens and the type specimen (B.M. Reg. No. 1864.5.15.8).

Pseudocheilinus hexataenia (Bleeker)

Four specimens all taken from pieces of coral. Three from Sanafir Island of 19, 23, and 29 mm. and one from Sherm Sheikh of 22·5 mm.

SCARIDAE

Leptoscarus vaigiensis (Quoy & Gaimard)

One specimen of 100 mm. collected on the reef at Abu Zabad at low tide.

Sub-order ACANTHUROIDEA

Acanthurus nigrofuscus (Forskål)

Three specimens collected at Mualla by cast-net (2 of 57 and 86 mm.) and at Abu Zabad at low tide (1 of 55 mm.).

Sub-order TEUTHIDOIDEA

Teuthis rivulatus (Forskål)

Five specimens taken by cast-net at Um Nageila (3 of 217, 220, and 235 mm.) and Sanafir Island (2 of 130 and 172 mm.).

Sub-order SCOMBROIDEA

Thynnus (Neothunnus) albacora (Lowe)

One specimen of 1,070 mm. obtained from Arab fishermen who were catching this fish and the one following at a depth of about 100 metres, a few miles south of Aqaba.

Euthynnus (Katsuwonus) pelamis (Linnaeus)

One specimen of 670 mm. obtained a few miles south of Aqaba from local fishermen.

Scomberomorus commerson (Lacépède)

One specimen of 860 mm. from Sanafir Island, caught by trolling spoon-bait.

Sub-order GOBIOIDEA

ELEOTRIDAE

****Eviota gymnocephalus*** M. Weber

Fourteen specimens, all obtained from pieces of coral brought up by a diver (5 from Sanafir Island from 10·0 to 16·0 mm.; 4 from Sherm Sheikh from 8·0 to 14·0 mm.; 1 from Sherm-el-Moiya of 15·0 mm.; 2 from Graa of 9·5 and 10·0 mm.; and 2 from Dahab of 13·0 and 15·5 mm.).

****Eviota distigma*** Jordan and Seale

Four specimens obtained from pieces of coral at Sherm Sheikh (3 from 13·0 to 17·0 mm.) and Graa (1 of 14·0 mm.).

Hetereleotris vulgare (Klunzinger)

Eighteen specimens collected from pieces of coral at the following localities: Sanafir Island (10 from 18·0 to 26·0 mm.), Tiran Island (1 of 17·0 mm.), Mualla (3 from 18·0 to 23·0 mm.), Dahab (4 from 19·0 to 25·0 mm.).

This species has only been recorded from the Red Sea.

Klunzinger (1870) remarks that the body of this fish appears to be without scales. I was also unable to find any trace of scales.

GOBIIDAE

Bathygobius fuscus (Rüppell)

Three specimens collected at Dahab (1 of 34·0 mm.), Mualla (1 of 50·0 mm.), and Abu Zabad (1 of 47·0 mm.). All were taken close inshore where they were found under stones and rocks.

Acentrogobius ornatus (Rüppell)

Two specimens of 38·0 and 58·0 mm. taken under stones at Abu Zabad at low tide.

Gobiodon quinquestrigatus (Cuvier & Valenciennes)

Forty-four specimens, all obtained from pieces of coral at the following localities: Dahab (7 from 16·5 to 38·0 mm.), Sanafir Island (24 from 12·5 to 38·0 mm.), Tiran Island (10 from 16·0 to 37·0 mm.), and Sherm Sheikh (3 from 22·0 to 30·0 mm.).

****Gobiodon erythrospilus*** Bleeker

Three specimens obtained from coral at Dahab (2 of 34·0 and 37·0 mm.) and Tiran Island (1 of 32·0 mm.).

Gobiodon citrinus (Rüppell)

Six specimens obtained from pieces of coral at Sanafir Island (4 from 27·5 to 32·0 mm.) and Sherm Sheikh (2 of 26·0 mm.).

Paragobiodon echinocephalus (Rüppell)

Three specimens from 20·0 to 23·0 mm. taken from a piece of coral at Sanafir Island.

Sub-order BLENNIOIDEA

BLENNIIDAE

Enchelyurus kraussii (Klunzinger)

One specimen of 30 mm. taken from a piece of coral at Graa. This species has only been recorded from the Red Sea.

Cirripectus variolosus (Cuvier & Valenciennes)

One specimen of 31·0 mm. collected on the reef at Abu Zabad.

Istiblennius edentulus (Bloch & Schneider)

Twenty-five specimens collected under stones and rocks at Abu Zabad (15 from 46·0 to 84·0 mm.) and Dahab (10 from 25·0 to 57·0 mm.).

Istiblennius fasciatus (Bloch)

Two specimens from Abu Zabad (1 of 47·0 mm.) and Sanafir Island (1 of 48·0 mm.).

CONGROGADIDAE

Haliophis guttatus (Forskål)

Four specimens obtained from pieces of coral at Sanafir Island (3 of 50·0, 67·0, and 81·0 mm.) and Sherm Sheikh (1 of 60·0 mm.).

This species appears to be restricted to the Red Sea.

CLINIDAE

****Helcogramma trigloides*** (Bleeker)

One specimen of 27·0 mm. found in a piece of coral at Mualla.

Sub-order MUGILOIDEA

SPHYRAENIDAE

Sphyraena jello Cuvier & Valenciennes

One specimen of 530 mm. taken by trolling spoon-bait at Sanafir Island.

Sphyraena picuda Bloch. Schneider

One specimen of 760 mm. taken by spoon-bait at Sanafir Island.

MUGILIDAE

Oedalechilus labiosus (Cuvier & Valenciennes)

Eight specimens taken by cast-net at Mualla (2 of 101 and 104 mm.) and Sherm Sheikh (6 from 96 to 127 mm.).

Liza seheli (Forskål)

One specimen of 300 mm. taken by cast-net at Dahab.

Liza crenilabis (Forskål)

One specimen of 69·5 mm. from Dahab and eight specimens from 101 to 164 mm. from Sanafir Island taken by cast-net.

ATHERINIDAE

Hypoatherina gobio (Klunzinger)

Twenty-nine specimens caught by dip-net and a light at night-time at the following

localities: Dahab (7 from 26·0 to 82·0 mm.), Sanafir Island (13 from 46·0 to 92·0 mm.), and Sherm Sheikh (9 from 20·0 to 74·0 mm.).

This species is apparently confined to the Red Sea.

Sub-order SCLEROPAREI

Scorpaenidae

**Scorpaenopsis albobrunneus* (Günther)

Twenty-two specimens, all obtained from pieces of coral brought up by a diver at the following localities: Dahab (8 from 19·0 to 44·0 mm.), Tiran Island (2 of 35·0 and 40·0 mm.), Sanafir Island (7 from 21·0 to 48·0 mm.), Sherm Sheikh (5 from 19·0 to 35·0 mm.).

Pterois volitans Linnaeus

Three specimens taken at Dahab (1 of 155 mm.), Hobeik (1 of 190·0 mm.), and Abu Zabad (1 of 51·0 mm.).

Order *DISCOCEPHALI*

Echeneididae

Echeneis neucrates Linnaeus

One specimen of 617 mm. caught by hand-line at Sherm Sheikh.

Order *PLECTOGNATHI*

Balistidae

Odonus niger (Rüppell)

Six specimens caught by hand-line at Sherm Sheikh (4 from 143·0 to 186·0 mm.) and Hobeik (2 of 240·0 and 285·0 mm.).

Balistapus undulatus (Mungo Park)

Two specimens. One of 184 mm. caught by hand-line at Hobeik and one of 35 mm. obtained from a piece of coral.

Rhinecanthus assasi (Forskål)

Four specimens taken at Abu Zabad (2 of 205 and 210 mm.) and Sanafir Island (2 of 170 and 190 mm.).

This species seems to be restricted to the Red Sea, the Gulf of Aden, and the Indian Ocean coast of Arabia.

ALUTERIDAE

Oxymonacanthus halli sp. nov.

(FIG. 3)

Two specimens, the holotype of 38·0 mm. and one paratype of 39·5 mm. taken from a piece of coral at Sanafir Island in the northern Red Sea.

(In the description which follows, measurements and counts of the holotype precede those of the paratype which are placed in brackets.)

Body proportions (relative to a standard length of 100): Greatest depth 35·5 (36·1); length of head 34·8 (35·4); predorsal length (from tip of snout to origin of dorsal fin) 55·5 (55·7); preanal length 61·8 (62·0); depth of caudal peduncle 14·4 (13·3); length of pectoral fin 9·9 (9·5); height of first dorsal spine 23·0 (24·0).

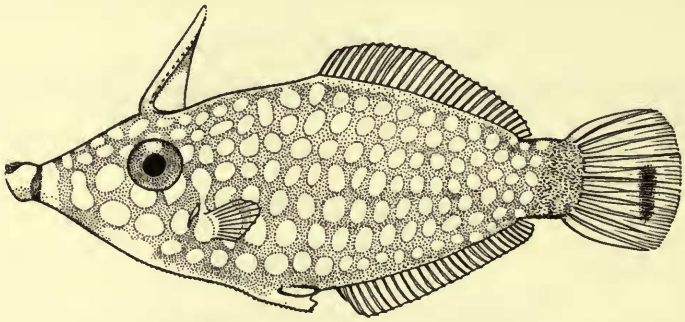

FIG. 3. *Oxymonacanthus halli* sp. nov.

Head proportions (relative to a head length of 100): Length of snout 64·0 (64·3); horizontal diameter of eye 26·4 (25·0).

Fin rays: Dorsal II, 28 (II, 27); anal 27 (25); left pectoral 10 (10); caudal 12.

Body covered with very numerous spinules, which become larger (about twice the length of those immediately behind the eye) and fewer on the caudal peduncle, particularly over the lateral, median regions. These spinules extend out to about three-quarters the length of each caudal ray and are not found on the tip of the snout in front of the brown pigment band which encircles it. First dorsal spine studded anteriorly and laterally with blunt spines, while posteriorly there are two rows of 9 or 10 rather larger blunt spines, the lower of which, at least, project backwards and downwards. Second dorsal spine very small. Immediately posterior to the first dorsal spine there is a fairly deep, wide groove in the back, of much the same length as this spine.[1] Pelvic spine supporting a small ventral flap. Dorsal, anal, and pectoral rays unbranched. Caudal rays branched except for the upper and lower outermost rays which are stouter at the base than the inner rays. Jaws meeting dorsally at the tip of the snout.

General colour blue with longitudinal rows of roughly circular deep yellow spots.

[1] Presumably the long dorsal spine folds into this groove, but I have been unable to unlock the trigger mechanism by pressure on the small second spine.

Between the origin of the dorsal and anal fins nine rows of these spots can be counted. Tip of snout yellow in front of the brown pigment ring which encircles it. Membrane of dorsal fin yellow, pelvic flap orange with a black edging. Caudal with a black vertical bar of pigment. Iris golden with six symmetrically arranged slate blue sectors.

This species differs from *Oxymonacanthus longirostris* (Bloch & Schneider), the only other species of this genus, in the following:

	O. halli	*O. longirostris*[1]
Dorsal rays . . .	27 and 28	31–32
Anal rays . . .	25 and 27	29–30
Pectoral rays . .	10	11–12

In addition there are certain differences in the colour pattern.

1. In *Oxymonacanthus halli* there are no longitudinal yellow stripes in front of the eye as are usually found in *O. longirostris*.
2. There are 9 longitudinal rows of yellow spots (counting across the body between the origins of the dorsal and anal fins) in *O. halli*, whereas in *longirostris* there are usually 7 (occasionally 6 or 8). The number of spots in each row is also greater in the new species. There are 18 or 19 (counting along the row behind the eye), whereas in *longirostris* there are 12–16.
3. In *O. longirostris* there is usually a small area of the abdomen just above the pelvic flap which is differentiated from the rest of the body by being brown in colour and dotted with small white spots. This is absent in the two specimens of *O. halli*.

I have much pleasure in naming this species after Major H. W. Hall, M.C., the owner of M.Y. *Manihine*.

Ostraciontidae

Ostracion tuberculatus Linnaeus

Two specimens of 270 and 300 mm. taken by cast-net at Sanafir Island.

Lagocephalidae

Lagocephalus sceleratus (Forster)

Four specimens from 260 to 280 mm. taken by hand-line at a depth of 10 fathoms at Sanafir Island.

Tetraodontidae

Amblyrhynchotes diadematus (Rüppell)

One specimen of 146 mm. taken by cast-net at Mualla. This species is confined to the Red Sea.

[1] Counts and measurements based on specimens from Samoa (1) (standard length 79·0 mm.), Amboyna (1 of 70·0 mm.), Ponape, Caroline Islands (2 of 43 and 65 mm.), New Britain (1 of 57·0 mm.), and one (no locality given) from Bleeker's collection (67 mm.).

Arothron hispidus (Linnaeus)

Two specimens of 285 and 340 mm. taken by cast-net at Sanafir Island.

These two specimens and another from the Gulf of Suez all have much more numerous and smaller white spots on the body than in examples taken outside the Red Sea.

CANTHIGASTERIDAE

****Canthigaster cinctus*** (Solander)

One specimen of 65 mm. taken by a fish-trap at Aqaba from a depth of 10 fathoms.

DISCUSSION

Among the 113 species considered in this report are a number which appear to be confined to the Red Sea. They may be subdivided as follows:

A. Almost certainly endemic

Pseudochromis olivaceus Rüppell
Crenidens crenidens crenidens (Forskål)
Diplodus noct ((Ehrenberg) Cuvier & Valenciennes)
Chaetodon fasciatus Forskål
Dascyllus marginatus marginatus (Rüppell)
Haliophis guttatus (Forskål)
Hypoatherina gobio (Klunzinger)
Amblyrhynchotes diadematus (Rüppell)

B. Possibly endemic

Hetereleotris vulgare Klunzinger
Enchelyurus kraussii Klunzinger
Oxymonacanthus halli Marshall

(The first two species are small and inconspicuous)

C. Species with Red Sea forms distinguishable from those of the Indian Ocean

Spratelloides gracilis (Schlegel)
Therapon jarbua (Forskål)
Platax orbicularis (Forskål)
Arothron hispidus (Linnaeus)

The number of species collected by this expedition probably represents about one-fifth of the total fish fauna of the Red Sea (Klunzinger, 1870 and 1871, lists about 490 species). If it is a representative sample, then about 10 per cent. of the species (and sub-species) known from this area are endemic. Moreover, to judge from the work on this collection, this percentage may well prove to be considerably higher, when more material becomes available for study.

Before discussing how these endemic elements may have originated it will be necessary to outline briefly the geological history of the Red Sea area. Although

the evidence is rather incomplete it seems that the formation of the main physical features were completed during the Pliocene and that during this time the Red Sea became connected with the Gulf of Aden and the Indian Ocean. Fox (1926) suggests that the invasion of Indian Ocean species into the Red Sea occurred some time after the Middle Pliocene. (Earlier an ancestral Red Sea appears to have come into being as the result of the faulting of Eocene strata followed by the filling of the resulting depression with water from the north. Later on the Red Sea appears to have lost its connexion with the northern Tethys Sea, for during Miocene times it shrank in area giving rise to great deposits of rock salt.) Continuing from middle Pliocene times there seems no doubt that there was again a connexion between the Mediterranean (Tethys Sea) and the Red Sea (the latter now containing a mixed Mediterranean and Indian Ocean fauna), but when the Gulf of Suez became cut off from the Mediterranean is not very certain.

This would seem to be the generally accepted geological history of the Red Sea, but Sewell (1948) has considered the implications of Zeuner's (1945) work on the Pleistocene period. Zeuner suggests that during the last Glacial period the sea-level fell as the result of ice formation, his figure for the Mediterranean being —100 metres, while a low level of —200 metres has been suggested for the penultimate glaciation.

Sewell (1948) concludes that this lowering of sea-level might well have left the shallow sill at the southern end of the Red Sea uncovered, which '. . . must have resulted in the almost complete disappearance of the Red Sea as it exists today and its reduction to two small inland lakes which were in all probability hypersaline. Under such changes as these it is difficult to suppose that anything of the marine fauna can possibly have survived, and the original fauna of the Tethys Sea that was derived from the Indo-Pacific region must have disappeared.' Following from this the sea-level once again rose at the end of the Glacial period, resulting in a second and final influx of species from the Indian Ocean into the Red Sea.

Concerning the origin of forms peculiar to the Red Sea there are certainly two possibilities:

1. That they have evolved from species entering the Red Sea.
2. That they may be the only survivors of species which originally lived in the Indian Ocean. It might be suggested, for example, that the Indian Ocean representatives of these species have been eliminated during geological history whereas conditions in the Red Sea favoured their survival.

A third possibility of whether the endemic forms are relics from the ancestral Red Sea seems so unlikely that it will not be considered beyond pointing out that the presence of great rock-salt deposits, probably of Miocene age, implies that this early sea must have been subject to extensive evaporation. As already mentioned, Sewell (1948) concluded that this would be likely to happen and that it most probably resulted in a mass extinction of the marine fauna.

Beginning with the second suggestion, it seems somewhat improbable that this fairly high number of endemic forms should have all possessed the potentialities of surviving in the Red Sea while the Indian Ocean ancestral stock perished. Following

the formation of the 'modern' Red Sea the main hydrological features would gradually have evolved, that is, higher summer temperatures and greater salinities, which now distinguish it from the Indian Ocean. Such changes would have tended to bring about correlated changes in the fish fauna (among them extinction) rather than the preservation of species. To put it another way, it seems unlikely that these forms should have all been pre-adapted to conditions in the Red Sea. While it is not possible to state the latter with certainty, it is of interest that the Red Sea supports fewer species of fishes than the Indian Ocean. Sewell (1948) has similar findings for the free-swimming planktonic Copepoda and suggests that many species which are widely distributed in the Indo-Pacific are unable to survive the changes in salinity and temperature on being carried into the Red Sea.

Turning to the first suggestion, if a number of the ancestral Indian Ocean immigrants have evolved into species and sub-species peculiar to the Red Sea, there should be some evidence for this today. It would be reasonable to expect to find at least some of these endemic Red Sea forms pairing off with the present-day Indian Ocean representatives. Regan (1906–1908) and Meek & Hildebrand (1923), when considering the marine fishes of Panama, have remarked on the many close parallels between the faunas of the opposite sides of the isthmus. It is generally considered that the formation of the Isthmus of Panama during late Pliocene times separated many species into Atlantic and Pacific populations which have diverged in isolation.

In the Red Sea there are certain endemic species which are paired with others from the Indian Ocean. From this collection there are the following pairs:

Red Sea	*Indian Ocean*
Diplodus noct (C.V.)	*Diplodus sargus* (L.) (also occurs in the Med.)
Chaetodon fasciatus Forskål	*Chaetodon lunula* Lacépède
Haliophis guttatus Forskål	*Haliophis malayanus* M. Weber
Oxymonacanthus halli Marshall	*Oxymonacanthus longirostris* (Bloch & Schneider)

While the members of these pairs may well have arisen by the separation of an original species into Red Sea and Indian Ocean populations, they are not sufficiently closely related to draw any certain conclusions as to their past history. Instead, it will be better to concentrate on infra-specific categories. Here there are the proposed sub-species of *Dascyllus marginatus* and the examples listed earlier of differences between Red Sea and Indian Ocean populations of certain species. Judging from the impressions gained in working out this collection and from numerous instances in the literature[1] where Red Sea examples of a species can be distinguished from others from the Indian Ocean, there can be little doubt that when good series of specimens from both areas are available, more species will be found to have Red Sea 'forms'.

The evolution of these endemic elements implies that after entering the Red Sea they became isolated to some degree. Leaving aside problems concerning the Suez Canal, entry via the Gulf of Aden is through the narrow Strait of Bab-el Mandeb, inside which is a shallow sill, where the greatest depth is only about 100 metres. Climatic conditions and the basin-like character of the Red Sea are the predominating

[1] Particular reference may be made to Fraser-Brunner (1950), who remarks that '... among the Chaetodonts at least I find that few or none of the known Red Sea forms are identical with those outside'.

factors controlling the temperature and salinity of the waters, and as already mentioned, the latter features were evolved after the formation of the 'modern' Red Sea. Today very soon after entering the Red Sea the salinity rises by about 2‰ and in summer the surface temperature increases by about 3–5° C. In winter there appears to be little difference between the surface temperatures of the Red Sea and the Gulf of Aden (data from Sverdrup, Johnson, & Fleming, 1942).

Perhaps this quite abrupt change in one or both physical factors may be a barrier to the exchange of Red Sea and Gulf of Aden fishes and has been so long enough for new forms to have arisen. Perhaps the habits of the fishes themselves may be another factor, species which are closely dependent on coral life and less migratory being more prone to differentiation than the more active pelagic species. (While there is the possibility of the larvae of the former types being carried out of the Red Sea (or into it), younger stages are usually more 'exacting' than adults in the physical conditions necessary for their existence; thus such an event may prove disastrous.) Again owing to the changes in temperature and salinity which have occurred since the formation of the Red Sea, certain species may have become reproductively isolated from their Indian Ocean ancestors, through the evolution of differing breeding seasons. In conclusion, however, it should be added that these are no more than suggestions to be tested in the light of further knowledge.

If more data were available on the fish fauna it would be interesting to compare and contrast the Red Sea–Indian Ocean relationships with those found across the Straits of Panama. Concerning the latter area, Gilbert & Starks (1904) in discussing the parallels between the two faunas concluded that:

> 'The ichthyological evidence is overwhelmingly in favour of the existence of a former open communication between the two oceans, which must have closed at a period sufficiently remote from the present to have permitted the specific differentiation of a very large majority of the forms involved. That this differentiation progressed at widely varying rates in different instances becomes at once apparent. A small minority of the species remain wholly unchanged, so far as we have been able to determine that point. A large number have become distinguished from their representatives of the opposite coast by minute (but not "trivial") differences which are wholly constant. From such "representative forms" we pass by imperceptible gradation to species much more widely separated whose immediate relation in the past we cannot confidently affirm.'

Later work by Meek & Hildebrand (1923) did not change these conceptions, except that it was found that fewer species could properly be regarded as common to both coasts and more species were discovered with representative Atlantic and Pacific forms.

It is not proposed on the present limited data to draw conclusions regarding rates of evolution in the Red Sea fauna. Direct comparison with the Panama findings is not, of course, possible for two main reasons: firstly that there is a connexion between the Red Sea and the Indian Ocean (which may make for genetic interchange between the two faunas), and secondly, that there are often greater differences in temperature (but not in salinity) between Red Sea and Indian Ocean waters than exist across the Straits of Panama (this aspect will be discussed later). Whether the degree of endemism of the Red Sea fauna could have been attained since the last Glacial

period (if Zeuner's (1945) figures of drop in sea-levels and Sewell's (1948) conclusions from these are considered), is a question which will best be considered when the large collection of fishes recently obtained from Sudanese waters has been studied.

Finally the fact that the Red Sea is for part of the year warmer and always more saline than Indian Ocean waters must be considered as a 'conditioning factor' in the evolution of Red Sea forms. Before this can be done a list of the differences between closely related forms will be given.

Spratelloides gracilis. The Red Sea populations tend to have fewer pectoral and anal rays than those from the Japanese area.

Therapon jarbua. The Red Sea form has fewer dorsal spines and a slimmer body form.

Diplodus noct. This differs from *D. sargus* from the Indian Ocean in the slimmer body form, the tendency for the dorsal and anal fins to have fewer rays, the smaller number of scale rows above and below the lateral line, and the fewer gill-rakers on the first arch.

Crenidens crenidens. The Red Sea sub-species differs in the slimmer body form, the fewer scale rows above and below the lateral line, and the lesser relative height and length of the soft dorsal and pelvic fins respectively.

Platax orbicularis. Red Sea examples tend to have fewer pectoral rays than those from the Indo-Pacific.

Dascyllus marginatus. The Red Sea sub-species differs from that of the Indian Ocean in the tendency to have fewer pectoral rays, relatively longer soft dorsal and anal fins, and generally lesser developed pigmentation.

Oxymonacanthus halli. Differs from *O. longirostris* from the Indo-Pacific in having fewer dorsal, anal, and pectoral rays. There are also differences in the colour pattern.

It is interesting to consider these differences in relation to present data concerning the correlations of character with environment in fishes. It is well known that the number of fin rays and scales often appears to be inversely related to the temperature with which the above data appear to be in agreement. But a study of the charts of surface temperatures contained in the Monthly Meteorological Charts of the Indian Ocean (M.O. 519. H.M. Stationery Office) shows that from January until May northern Red Sea waters are consistently cooler than those of the Indian Ocean, while evidence is accumulating that many Red Sea fishes spawn during January and February—a problem to be discussed more fully in a later paper. On the other hand, the number of parts of a fish may have a direct relationship with salinity. Precisely what would be the apparent effect of high temperatures and increased salinities on numbers of fin rays or scales in Red Sea fishes (compared to their nearest relatives from the Indian Ocean) is impossible to predict. However, recent work by Heuts (1949) showing the combined effect of temperature and salinity on the number of fin rays in *Gasterosteus aculeatus* may be of particular significance here. Considering only the marine B population, increase in salinity at 10° C. led to an increase in the mean number of dorsal and anal rays, whereas at 23° C. the effect of this was to produce a decrease.

Concerning body form, Hubbs (1940) states that: 'Forms of warmer water, and in the sea those of brackish water, typically have deeper bodies and larger heads than

those of colder or more saline waters.' In the Red Sea there may be a correlation with the increased salinity for in three of the examples listed above, the Red Sea form had a slimmer body shape. More data are desirable before arriving at any conclusions, but these are interesting problems and further comparative studies of Red Sea and Indian Ocean fishes may well contribute to a closer understanding of them. At the same time experimental studies would be desirable. It need only be added that close correlation between environment and structure need not mean that the changes are entirely dependent on the environment. There is evidence from other work that the genotype is also involved. It will be apparent from the recognition of certain sub-species and the trend of this discussion that the view is held that it is unlikely that these correlations solely arise from the action of the environment on the phenotype.

To conclude, it looks as though partially enclosed seas, such as the Red Sea, may be centres for the evolution of new forms. I am much indebted to Dr. A. E. Parr for drawing my attention to the Gulf of California, which also harbours certain endemic species and sub-species. Setchell (1937), referring to earlier work in the gulf, points out that fifteen species or varieties of *Sargassum* are endemic, '. . . thus indicating what is borne out by the remaining marine flora of this body of water, that it forms a "pocket" of more than ordinary distributional interest'. Burkenroad (1938) notes that certain penaeid prawns are confined to the Gulf of California, while Parr (1931) took certain species of deep-sea fishes in the gulf that had originally been described from there by Garman (1899) and have not so far been taken outside this area (although neighbouring areas have been well worked).

More hydrological and biological data will be necessary to discover the degree of isolation of the fauna of these marine pockets. Mayr (1942) has remarked that: 'In the sea isolation is rarely complete and the partially isolated populations are normally very large. It is mainly for this reason that marine species have fewer sub-species than terrestrial species and that the entire evolution in the sea is slower and more conservative.' Further work on partially enclosed areas should help towards an understanding of the evolution of new forms in the seas.

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